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09/941,612	08/30/2001	Yoshinobu Aoyagi	1794-0141P	6758

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1792	

NOTIFICATION DATE	DELIVERY MODE
12/23/2008	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mailroom@bskb.com

Office Action Summary	Application No.	Applicant(s)	
	09/941,612	AOYAGI ET AL.	
	Examiner	Art Unit	
	MATTHEW J. SONG	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 September 2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *37-44* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *37-44* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 37 and 39-43 are rejected under 35 U.S.C. 102(b) as being anticipated by Kobayashi et al (US 4,829,022).

Kobayashi et al teaches Group III (Ga) atoms are supplied to the substrate so that one atomic layer is formed by one irradiation of the Ga beam (first crystal raw material) and then atoms of Group V (As) (second raw material) are supplied after the supply of Group III atoms has been completed, whereby the III-V molecules are formed (col 9, ln 25 to col 10, ln 51). Kobayashi et al also teaches the step of doping impurities which is required for the fabrication of various PN junction devices is carried out by supplying p-type (Beryllium) impurity and n-type (Si) impurity simultaneously with the supply of Group III atoms (col 12, ln 35-50). Kobayashi et al also teaches the impurities are efficiently introduced at the lattice positions of the atoms of Group III and the doping was accomplished with a high degree of activation rate as compared with conventional MBE method (col 12, ln 35-50), this reads on supplying p-type and n-type impurity before the step of supplying the second raw material, thereby doping an impurity pair of the p-type and n-type into only the first layer.

Referring to claims 39, 41, Kobayashi et al teaches simultaneously supplying the p-type and n-type dopants (col 12, ln 35-50).

Referring to claims 40, 43 Kobayashi et al teaches simultaneously supplying p-type dopant, n-type dopant with the supply of Group III atoms (col 12, ln 35-50), this reads on supplying n-type and p-type dopant after starting the supply of the first crystal raw material.

Referring to claim 42, Kobayashi et al teaches Ga as the first crystal material and As as the second crystal material (col 10, ln 20-35).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 37-43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Kobayashi et al (US 4,829,022).

Nishizawa et al discloses a method of growing doped semiconductor monolayers, note entire reference, comprising raw material gases of Gallium (Ga) and Arsenic (As), where Ga is supplied for 0.5 to 10 seconds, the chamber is evacuated, this clearly suggests applicant's purged for a predetermined time, and As is supplied for 2 to 200 seconds and the cycle is repeated (col 7, ln 1-67; col 8, ln 1-30 and Fig 7B and Fig 11). Nishizawa et al also discloses a p-type layer is formed by introducing an impurity gases and Ga simultaneously but alternately with an As source, where the impurity gas is an Mg, Zn or Cd containing gas or Silane. Nishizawa et al also discloses a n-type layer doped with Se or S and the impurity gas is introduced cyclically with the Ga gas and As gas or the impurity gas and Ga gas are introduced simultaneously but alternately with the As gas (col 8, In 31-60). Nishizawa et al also discloses forming pnp bipolar transistors (col 8, ln 61-67). Nishizawa et al also discloses nozzles 44, 45 and 46 for introducing gaseous compounds used for impurity doping for introducing group II, IV and VI gases (col 10, ln 50-67). Nishizawa et al also discloses different modes of doping, where the dopant is added at the exhaustion of an As gas, the introduction of a Ga gas, the exhaustion of a Ga gas or at the introduction of As gas (col 11-13 and Fig 11). Nishizawa et al also discloses other III-V semiconductors are applicable to the invention (col 14, ln 5-55). Nishizawa et al also discloses introduction of a Ga source gas and a group II dopant simultaneously to form a p-type layer (col 8, ln 30-45) and the introduction of a group IV dopant after the introduction of a Ga source gas (col 15, ln 5-50). Nishizawa et al also discloses selection of the timing of doping with respect of the source gas introduction is based on the desired dopant type for the monolayer being grown

(col 15, ln 45-55). Nishizawa et al teaches supplying reactants for a short period of time (col 11, ln 50-60), this clearly suggests applicants pulsed manner. Nishizawa et al also teaches impurity sites in the crystal lattice can be controlled by selecting the introduction timing of the dopant gas. (col 13, ln 45-60).

Nishizawa et al does not disclose the given time for supplying each of the impurity raw materials are close to each other.

Kobayashi et al teaches Group III (Ga) atoms are supplied to the substrate so that one atomic layer is formed by one irradiation of the Ga beam (first crystal raw material) and then atoms of Group V (As) (second raw material) are supplied after the supply of Group III atoms has been completed, whereby the III-V molecules are formed (col 9, ln 25 to col 10, ln 51). Kobayashi et al also teaches the step of doping impurities which is required for the fabrication of various PN junction devices is carried out by supplying p-type (Beryllium) impurity and n-type (Si) impurity simultaneously with the supply of Group III atoms (col 12, ln 35-50). Kobayashi et al also teaches the impurities are efficiently introduced at the lattice positions of the atoms of Group III and the doping was accomplished with a high degree of activation rate as compared with conventional MBE method (col 12, ln 35-50), this reads on supplying p-type and n-type impurity before the step of supplying the second raw material, thereby doping an impurity pair of the p-type and n-type into only the first layer.

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nishizawa et al with Kobayashi et al's doping p-type and n-type impurities into the lattice positions of the atoms of the Group III atoms to achieve a high degree of activation.

Referring to claim 38, the combination of Nishizawa et al and Kobayashi et al does not teach supplying one of the n-type or p-type dopant after supplying the one of the n-type or p-type dopant. However, Nishizawa et al teaches doping a Ga layer by supplying a dopant while supplying Ga or after supplying Ga but before supplying As (Fig 11 and col 11, ln 25-60) and Nishizawa et al also teaches impurity sites in the crystal lattice can be controlled by selecting the introduction timing of the dopant gas. (col 13, ln 45-60). Therefore, It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Kobayashi et al to supplying one dopant during Ga deposition and the other dopant after the Ga deposition but before As is supplied, as suggest by Nishizawa, to control the impurity sites in the crystal lattice.

Referring to claims 39-43, see the remarks above in regards to the Kobayashi reference.

5. Claim 44 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Kobayashi et al (US 4,829,022) as applied to claims 37-43 above, and further in view of Edmond et al (US 5,739,554) and Manabe et al (US 6,472,690).

The combination of Nishizawa et al and Kobayashi et al teaches all of the limitations of claim 44, as discussed previously, including using silane as a Si dopant and III-V compound semiconductors can be doped ('139 col 14, ln 1-25 nd col 13, ln 30-60). The combination of Nishizawa et al and Edmond et al does not teach the second raw material is NH_3.

Edmond et al teaches a gallium nitride (GaN) layer co-doped with both a Group II acceptor and Group IV donor (col 4, ln 50-67), where the group II acceptors include Zn or Mg and the Group IV donors include Si or Ge (col 6, ln 20-50), this clearly suggests applicant's time

for supplying each of the impurity raw materials are close to each other. Edmond et al also discloses the GaN layer is formed by CVD, where Trimethylgallium (TMG), ammonia, silane and biscyclopentadienyl magnesium, $(Cp)_2Mg$ are used as reactant gases (col 7, ln 45-67 and col 8, ln 1-50). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Kobayashi et al with Edmond et al's co-doped GaN deposition with a second raw material NH_3 because the GaN layer is useful as an active layer (Abstract).

The combination of Nishizawa et al, Kobayashi et al and Edmond does not teach supplying TESi.

In a method of forming a gallium nitride compound semiconductor, note entire reference, Manabe et al teaches forming an n+ type Gallium nitride layer, using silane or tetraethylsilane (TESi) (Example 4). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al, Kobayashi et al and Edmond with Manabe et al because substituting known equivalents for the same purpose is obvious (MPEP 2144.06).

Referring to claim 44, the combination of Nishizawa et al, Kobayashi et al, Edmond and Manabe et al teaches supplying the group III metal with a dopant or supplying a dopant after the Group III is supplied but before the group V element is supplied (‘139 Fig 11); supplying n-type and p-type dopant into a Ga metal layer (‘022 col 12, ln 35-50); using TESi as a dopant ('690 Example 4); and NH_3 as the group V material and $(Cp)_2Mg$ ('554 col 7, ln 45-67 and col 8, ln 1-50).

Response to Arguments

6. Applicant's arguments with respect to claims 37-44 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MATTHEW J. SONG whose telephone number is (571)272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Kornakov can be reached on 571-272-1303. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Matthew J Song
Examiner
Art Unit 1792

MJS
December 17, 2008

/Robert M Kunemund/
Primary Examiner, Art Unit 1792